European Network of
Transmission System Operators
for Electricity

QUALITY OF DATASETS AND CALCULATIONS

FOR OPERATIONAL SECURITY ASSESSMENT

SECOND EDITION

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RGCE SG NETWORK MODELS & FORECAST TOOLS

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INTRODUCTION

During the last years, the ENTSO-E Subgroup "Network Models and Forecast Tools" has developed the exchange of complete network models in order to perform the following calculations:

- Day Ahead Congestion Forecast (**using "DACF" files**)
- After the fact analyses (**using "RTSN" files** : Real-Time Snapshot files)
- Various calculations (including symmetrical three phase short circuit calculations) on a typical peak load case (**using "RE" files**: Reference files).

Additionally, regional cooperation initiatives, like Coreso, CWE MC[1], SSC[2] and TSC[3] also use the same format for the following calculations:

- Capacity allocation, based on Two Days Ahead Congestion Forecast (**"2DCF" files**)
- Intraday Congestion Forecast (**"IDCF" files**)
- Close to real-time calculations (**using "RTSN" files on 15 minutes time intervals**)

According to Policy 4 of ENTSO-E RG CE Operational Handbook, each TSO has to provide its complete DACF load flow data set with exchange program on the EH ftp-server before 6 p.m. (C.E.T.), where it is accessible to all other participating TSOs. Daily (D-1) data sets will be supplied for all 24 timestamps by September 2013.

In order to facilitate the exchange of datasets, the UCTE Data Exchange Format was developed (first version: 2001, second version: 2003, third version: 2007). It is mandatory for all TSOs to exchange data in the current data exchange format.

This document replaces the document "Quality of calculations final version_20070213.DOC", which was issued by the UCTE SG NM&FT and specifies the process of dataset preparation, starting from the creation of single files up to the creation of merged models and provides requirements to which the datasets must comply before they can be used for merged model creation.

The following steps can be identified before a merged model is ready for use in a congestion management process:

1. Single file preparation
2. Validation of the single files
3. Data completion and scaling of single files
4. Sub control block merging
5. Merging
6. Assessment of the quality of calculations

[1] Central-Western European Market Coupling

[2] Security Service Centre

[3] TSO Security Cooperation

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1 SINGLE FILE PREPARATION

1.1 PROCEDURE

The single day ahead congestion forecast data sets for at least all mandatory timestamps need to be prepared after the market closure and before 18:00 CET. In order to **prepare the best forecast available**, the following statements are important:

- Ensure the single (DACF) files include all known results of market activities, including the trading of renewable energy, local redispatch, planned outages, forecast load schedules and verification of tie-line status with adjacent TSOs
- In case of expected internal congestion, based on (n-1) assessment and experience, try to relieve the grid by means of reconfiguration, cancelling planned maintenance or agreeing on redispatch with market parties (activation of bids) and also include these changes in the single files
- In accordance with Policy 4, these single files need to be made available on the EH ftp-server at 18:00 CET

1.2 CONTENT OF THE DATASET

Forecasts are inaccurate by definition. Nevertheless, the injections and voltage profiles **must be based on the best available information at that point in time**. This includes:

- Equipment model derived from the real-time dataset
- Operational limits identical to the limits that are used in real-time (these might differ for each timestamp)
- Production schedules, based on trading results and wind/solar forecasts
- MW/Mvar load schedules, based on historical data , taking into account holidays
- Realistic voltage profiles, expressed in tap positions and reference voltages on PV-nodes
- Correct substation topology and tap position of transformers
- Coherent x-node status (same status as the counterpart), including internal German d-nodes
- The injection values (P and Q) as well as the reference voltage values for PV and slack buses are the output values of a load flow calculations
- Fulfilment of the system balance for each electrical island: Sum of load injections + grid losses = Sum of generation injection + net interchange
- The slack deviation should be as low as possible (preferable below 2% of the total load), so that scaling of original files is not necessary at the time of merge
- Every change that has an impact on the load flows, such as topological changes, redispatch, unplanned outages that have an impact for several hours and updated forecasts for renewable power shall be included in intraday updates for all hours that are affected

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Additionally, the following modelling aspects are necessary for automatic security assessment (N-1 calculations) and operational processes involving grid elements identification over multiples timestamps:

- It shall be possible to uniquely identify each branch[4]
- The unique branch identification shall be identical for every timestamp
- All generators that could be used for redispatch shall be modelled on dedicated nodes (identical for every timestamp)[5]. This implies generator schedules and limits for each generator of a power plant.

Furthermore the following issues are highly recommended:

- Voltage control including three winding transformers and shunt elements
- Dedicated nodes (terminals) for all equipment on transmission voltage level ***in case of complex substations*** (e.g. 3/2 breaker configurations or in case of busbar sectionalisers:
  - Lines and transformers would have dedicated nodes at both sides, as much as possible (therefore all lines and transformers will have unique identification from a timestamp to another)
  - Busbar sections are modelled as dedicated nodes (semi-detailed topology)
  - Dedicated nodes are connected via busbar couplers (zero impedance): the status of these busbar couplers (connected or disconnected) are given by the topology results
- Use of (unique) geographical names and optional element names (mandatory instead of optional)
- The generator active power limits are based on available margins instead of physical limits, taking into account the restrictions imposed by NRAs
- Non-dispatchable units are modelled as nodes with both upper and lower active power limits equal to the current generation infeed
- For dispatchable units the static and nominal power for primary control are provided in order to compensate loss of power in N-1 calculations in a more realistic manner (primary response). This is necessary in order to be able to study cascading effects.
- Detailed modelling for phase shifting transformers (using the ##TT records)
- Three winding transformers modelled as three real elements two winding transformers[6]
- Modelling the lower voltage level observable area using real equipment types, thus avoiding the use of Ward equivalents

As long as the UCTE DEF format or CIM ENTSO-E Profile 1 is used, a bus oriented or semi-detailed data model can be exchanged. With the introduction of CIM ENTSO-E Profile 2, a switch oriented data model is recommended using incremental data.

[4] This could be accomplished by combining the first 7 characters of the connecting nodes with the optional element name or by combining the country code with the SCADA name in the element name

[5] This does not apply to infeed in decentralized grids

[6] Note that the third winding is usually connected to a voltage level that is not allowed by the current UCTE Data Exchange Format. This could be compensated by converting the model to a different voltage level. E.g. a 380/150/50 transformer could be converted to a 380/380/150 transformer.

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2 VALIDATION OF THE SINGLE FILES

The single files must fulfil certain requirements before they can be used for calculations. Some requirements are strict: non-fulfilment can cause non-convergence in the load flow, others are less strict: non-fulfilment will lead to less realistic results.

2.1 FILE RELATED REQUIREMENTS (UCTE DEF 2.0)

The file name convention is:

<yyyymmdd>_<HHMM>_<TY><w>_<cc><v>.uct, with

yyyymmdd: year, month and day,

HHMM: hour and minute,

TY: File type (FO = Day Ahead Forecast, SN = Snapshot, RE = Reference, LR = Long Term Reference, 2D = two days ahead forecast, 'hh' = Intraday Forecasts where 'hh' is for example '02' for two hours ahead intraday forecast)

w: day of the week, starting with 1 for Monday,

cc: the ISO country-code for national datasets, "UC" for UCTE-wide merged datasets without X nodes and "UX" for UCTE-wide merged datasets with X nodes,

v: version number starting with 0. If the version is "x", the file is to be ignored.

The filename must be in uppercase for reasons of file management on the ftp-server. Files that do not comply to the file name convention cannot be used in an operational process.

Requirement	Severity	Rule
FILE-NAME-01	FATAL	The file name has to comply to the file name conventions
FILE-SIZE-01	FATAL	File size has to be greater than 240 Bytes[7]

[7] This value is justified by the values used in the RG CE DACF files and can be updated if deemed necessary.

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2.2 FORMAT RELATED REQUIREMENTS – UCTE DEF

Each exchange format requires a specific set of rules. The UCTE data exchange format is a fixed format in terms of columns in each line, depending on the data block. The exact positions, the availability and order of mandatory data blocks are defined in the document "UCTE data exchange format for load flow and three phase short circuit studies (UCTE-DEF) – Version 02 (2007.05.01)".

Some syntax errors are "FATAL" errors and shall lead to the rejection of files and substitution in automated congestion forecast merge processes, decreasing the quality of the forecasts. In case of snapshots and reference files, it leads to multiple attempts to manually correct the files.

If the severity is indicated as "WARNING", the files can be used, but the data quality is expected to be limited.

2.2.1 STRUCTURE RELATED REQUIREMENTS

The following rules are used to check for completeness of the file and prerequisites for further processing:

Requirement	Severity	Rule
STRUCT-Z-01	FATAL	The line just after the line with the label ##N must be ##Z
STRUCT-General-01	FATAL	Each mandatory block must be defined (##N, ##L, ##T, ##R)
STRUCT-General-02	FATAL	Each block can't be defined more than once
STRUCT-General-03	FATAL	The block has to begin with ##C, ##N, ##Z, ##L, ##T, ##R or ##E. No other characters are acceptable.
FILE-FORMAT-01	FATAL	File must be in US-ASCII DOS format

2.2.2 SYNTAX RELATED REQUIREMENTS (GENERAL)

Requirement	Data block	Columns	Field	Severity	Rule
STRUCT-Comments-01	##C	1-14	Version ID	FATAL	The first line must be ##C 2007.05.01
STRUCT-Z-02	##N	4-5	CC identifier	FATAL	The code following the label ##Z must be an ISO country

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2.2.3 SYNTAX RELATED REQUIREMENTS (NODE DATA)

Requirement	Data block	Columns	Field	Severity	Rule
DATA-NODE-CODE -02	##N	1	CC	FATAL	The first character of each node code must be the UCTE country code
DATA-NODE-CODE-04	##N	7	Voltage level code	FATAL	The 7th character of node code must be a voltage level code 0,1,2,3,4,5,6,7,8,9
DATA-NODE-CODE-03	##N	1-8	Node code	FATAL	Node code contains only “standard” characters in upper case “0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZ_-.” and blank
DATA-NODE-STATUS-01	##N	23	Node status code	FATAL	The node status has to be 0 or 1. No other character is acceptable.
DATA-NODE-TYPE-1	##N	25	Node type code	FATAL	The node type has to be 0, 1, 2, or 3. No other character is acceptable.

2.2.4 SYNTAX RELATED REQUIREMENTS (LOAD DATA)

Requirement	Data block	Columns	Field	Severity	Rule
DATA-NODE-ActiveLoad-01	##N	34-40	P load (MW)	WARNING	Active load must be defined, blank is not allowed
DATA-NODE-ReactiveLoad-01	##N	42-48	Q load (Mvar)	WARNING	Reactive load must be defined, blank is not allowed

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2.2.5 SYNTAX RELATED REQUIREMENTS (GENERATOR DATA)

Requirement	Data block	Columns	Field	Severity	Rule
DATA-NODE-ActiveGeneration-01	##N	50-56	P gen (MW)	WARNING	Active generation must be defined and can be negative or positive (pumping plants)
DATA-NODE-ReactiveGeneration-01	##N	58-64	Q gen (Mvar)	WARNING	Reactive generation must be defined
DATA-NODE-PMIN-01	##N	66-72	P min (MW)	WARNING	Minimum permissible active generation must be defined when it is required (for example for reference case) and can be negative if there is only pure generation or positive for mix and/or pumping plants
DATA-NODE-PMAX-01	##N	74-80	P max (MW)	WARNING	maximum permissible active generation must be defined when it is required (for example for reference case) and can be negative or positive (for pumping)
DATA-NODE-QMIN-01	##N	82-88	Q min (Mvar)	WARNING	In case of PV node minimum permissible reactive generation must be defined
DATA-NODE-QMAX-01	##N	90-96	Q max (Mvar)	WARNING	In case of PV node maximum permissible reactive generation must be defined
DATA-NODE-PPTYPE-01	##N	128	Power plant type	WARNING	The node power plant type, if present, has to be H,N,L,C,G,O,W or F. No other character is acceptable.

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2.2.6 SYNTAX RELATED REQUIREMENTS (LINES DATA)

Requirement	Data block	Columns	Field	Severity	Rule
DATA-LINE-DEF-02	##L	19	Line order code	FATAL	Order code must be a "standard" character : 0123456789ABCDEFGHIJKL MNOPQRSTUVWXYZ
DATA-LINE-STATUS-01	##L	21	Line status	FATAL	Line status must be one of the values : 0,1,2,7,8,9

2.2.7 SYNTAX RELATED REQUIREMENTS (TRANSFORMER DATA)

Requirement	Data block	Columns	Field	Severity	Rule
DATA-TRF-DEF-02	##T	19	Transformer order code	FATAL	Order code must be a "standard" character : 0123456789ABCDEFGHIJKL MNOPQRSTUVWXYZ
DATA-TRF-STATUS-01	##T	21	Transformer status code	FATAL	Transformer status must be one of the values : 0,1,8,9

2.2.8 SYNTAX RELATED REQUIREMENTS (POWER EXCHANGE DATA)

Requirement	Data block	Columns	Field	Severity	Rule
DATA-EXCH-CC-01	##E	1-2	ISO code 1	WARNING	Country 1 of an exchange must be in the TSO list.
DATA-EXCH-CC-02	##E	4-5	ISO code 2	WARNING	Country 2 of an exchange must be in the TSO list.

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2.3 EQUIPMENT MODEL RELATED REQUIREMENTS

2.3.1 EQUIPMENT CONNECTIVITY RELATED REQUIREMENTS

Requirement	Field	Severity	Rule
DATA-NODE-CODE-6	Node CC identifier	FATAL	The first character of all node codes should correspond to the country code of the #Z section they belong to
TOPOLOGY-Connection-01		WARNING	All the X-nodes of the described network, defined in the ENTSO-E Boundary file must be defined in the dataset (i.e. out of operation X-nodes have to be included)
TOPOLOGY-Connection-02	Line terminal1	FATAL	Each X-node must be connected to one and only one node which is not an X-node
TOPOLOGY-Connection-02	Line terminal2	FATAL	Each X-node must be connected to one and only one node which is not an X-node
DATA-LINE-DEF-01	Line terminal1	FATAL	Both terminals of a line must be defined
DATA-LINE-DEF-05	Line terminal1	FATAL	Nodes of the line must belong into the same TSO. Except for the lines connected to X-nodes.
DATA-LINE-DEF-01	Line terminal2	FATAL	Both nodes of a line must be defined
DATA-LINE-DEF-05	Line terminal2	FATAL	Nodes of the line must belong into the same TSO. Except for the lines connected to X-nodes
DATA-LINE-DEF-04	Line voltage level 1	FATAL	The sending and the receiving node of a line must have the same voltage level[8], i.e. the same 7th character
DATA-LINE-DEF-04	Line voltage level 2	FATAL	The sending and the receiving node of a line must have the same voltage level[9], i.e. the same 7th character
DATA-LINE-DEF-03	Line order code	WARNING	Order code must be unique
DATA-TRF-DEF-01	Transformer terminal1	FATAL	Both terminals of the transformer must be defined
DATA-TRF-DEF-04	Transformer terminal1	FATAL	Both terminals of the transformer must belong into the same TSO
DATA-TRF-DEF-01	Transformer terminal2	FATAL	Both terminals of the transformer must be defined
DATA-TRF-DEF-04	Transformer terminal2	FATAL	Both terminals of the transformer must belong into the same TSO
DATA-TRF-DEF-03	Transformer order code	WARNING	Order code must be unique

[8] This is required by tools that use a per unit transformation for their calculations

[9] This is required by tools that use a per unit transformation for their calculations

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Requirement	Field	Severity	Rule
DATA-TRREG-DEF-01	Transformer terminals	WARNING	Transformer identification (terminals and order code) must be defined in the 2 windings transformers data definition
DATA-TapPosition-DEF-01	Transformer terminals	WARNING	Transformer identification (terminals and order code) must be defined in the 2 windings transformers data definition
TOPOLOGY-Connection-03	Nodes	WARNING	The number of branches connected to one node is lower than or equal to 16 [10]

2.3.2 EQUIPMENT PARAMETERS RELATED REQUIREMENTS - LINES

Requirement	Field	Severity	Rule
DATA-LINE-Resistance-01	Line resistance (Ω)	FATAL	Real line resistance must be positive
DATA-LINE-Resistance-02	Line resistance (Ω)	WARNING	Busbar coupler resistance must be zero
DATA-LINE-Reactance-01	Line reactance (Ω)	FATAL	Real line reactance must be defined
DATA-LINE-Reactance-03	Line reactance (Ω)	WARNING	Busbar coupler reactance must be zero
DATA-LINE-Susceptance-02	Line susceptance (µS)	WARNING	Busbar coupler susceptance must be zero
DATA-LINE-IMAX-01	Line max current limit	WARNING	Real line current limit must be positive
DATA-LINE-IMAX-02	Line max current limit	WARNING	Equivalent line current limit must be positive or blank
DATA-LINE-IMAX-03	Line max current limit	WARNING	Busbar coupler current limit must be positive or blank

2.3.3 EQUIPMENT PARAMETERS RELATED REQUIREMENTS - TRANSFORMERS

Requirement	Field	Severity	Rule
DATA-TRF-Voltage1-01	Voltage (non-regulated winding)	WARNING	Value for the voltage must be between 0.8 Un and 1.2 Un
DATA-TRF-Voltage2-01	Voltage (regulated winding)	WARNING	Value for the voltage must be between 0.8 Un and 1.2 Un
DATA-TRF-SN-01	Snom (MVA)	FATAL	Value must be positive, blank and zero is not allowed

[10] This value is justified by the values used in the RG CE DACF files and can be updated if deemed necessary.

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Requirement	Field	Severity	Rule
DATA-TRF-Resistance-01	Transformer resistance (Ω)	FATAL	Blank is not allowed, real transformer resistance must be greater than or equal to zero
DATA-TRF-Reactance-01	Transformer reactance (Ω)	FATAL	Blank is not allowed, absolute value of reactance must be greater than 0.05 Ω
DATA-TRF-Susceptance-01	Transformer shunt susceptance (µS)	WARNING	Blank is not allowed
DATA-TRF-Conductance-01	Transformer shunt conductance (µS)	WARNING	Transformer shunt conductance must be greater than or equal to zero
DATA-TRF-IMAX-01	Transformer current limit	WARNING	Current limit must be greater than zero
DATA-TRF-IMAX-02	Transformer current limit (non-regulated winding)	WARNING	Equivalent transformer current limit must be positive or blank
DATA-TRREG-PHASE-01	Phase regulation: voltage change per tap	WARNING	For LTCs, transformer phase regulation voltage change per tap should not be zero. Its absolute value should not be above 6%[11]
DATA-TRREG-PHASE-02	Phase regulation: number of taps	WARNING	The number of phase regulating taps cannot be negative and cannot exceed 18 [12]
DATA-TRREG-PHASE-03	Phase regulation: current tap position	WARNING	Transformer phase regulation tap must be lower or equal in absolute value than the number of taps
DATA-TRREG-PHASE-04	Phase regulation: target voltage for regulated winding	WARNING	Target value must be smaller than or equal to (Un + n*δU%*Un / 100) and greater than or equal to (Un - n*δU%*Un / 100) (where Un is the voltage level of the regulated winding)
DATA-TRREG-QUADRA-01	Angle regulation: voltage change per tap	WARNING	For Transformer with angle regulation, voltage change per tap should not be zero. Its absolute value should not be above 6% [13]
DATA-TRREG-QUADRA-02	Angle regulation: number of taps	WARNING	The value cannot be negative and cannot exceed 33 [14]
DATA-TRREG-QUADRA-03	Angle regulation:	WARNING	For Transformer with angle regulation, tap must be lower or

[11] This value is justified by the values used in the RG CE DACF files and can be updated if deemed necessary.

[12] This value is justified by the values used in the RG CE DACF files and can be updated if deemed necessary.

[13] This value is justified by the values used in the RG CE DACF files and can be updated if deemed necessary.

[14] This value is justified by the values used in the RG CE DACF files and can be updated if deemed necessary.

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Requirement	Field	Severity	Rule
	current tap position		equal in absolute value than the number of taps
DATA-TRREG-QUADRA-04	Angle regulation: angle	WARNING	The absolute value of the angle cannot exceed 180°
DATA-TRREG-QUADRA-05	Angle regulation type	WARNING	For Transformer with symmetrical angle regulation, type must be indicated as "SYMM"; for Transformer with asymmetrical angle regulation, type must be indicated as "ASYM", Blank type means "ASYM".
DATA-TapPosition-TAP-01	Transformer tap position	WARNING	Tap Transformer value must be between –N and +N, where N is the number of taps defined in transformer

2.3.4 DATA CONSISTENCY RELATED REQUIREMENTS

Requirement	Field	Severity	Rule
DATA-NODE-SLACK-01	Slack node ID	WARNING	Only one active slack node must defined for each electrical island (code 1: fixed θ, Q or 3 : fixed θ,V)
DATA-NODE-CODE-01	Node code	FATAL	Each node code must be unique in a data set
DATA-NODE-CODE-05	Node code	WARNING	The X-node defined in the ##ZXX section (inside ##N) should be defined in the official ENTSO-E Boundary file
DATA-NODE-VOLTAGE-01	Reference voltage for PV and nodes	WARNING	Reference value for the voltage must be between 0.8 Un and 1.2 Un (Un is the voltage level of the node defined by the 7th character of node code)
DATA-NODE-PLIMITS-01	Active generation	WARNING	Active generation must be within operational limits
DATA-NODE-QLIMITS-01	Reactive generation	WARNING	Reactive generation must be within operational limits
TOPOLOGY-Connection-03	X-node injection	WARNING	Balance of injections at a node must be zero if this node is not connected to any branches (i.e. all lines and transformers out of operation)

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Requirement	Field	Severity	Rule
DATA-TRREG-DEF-02		WARNING	Each transformer regulation, based on Node1, Node2 and Order code, has to be unique
DATA-TapPosition-DEF-02		WARNING	Each transformer tap, based on Node1, Node2, Order code and tap, has to be unique

2.4 LOAD FLOW RELATED REQUIREMENTS

2.4.1 LOAD FLOW CONVERGENCE

Although many different tools are used by TSOs, they are all obliged to provide datasets that are convergent, i.e. the calculated injections and voltages should be written to the DACF file for all PV nodes. Files that do not converge will not be used for merging. Note that only the largest electrical island is considered.

[Informative section] A standard Newton-Raphson algorithm, voltage control applied after 3rd iteration can be suggested.

2.4.2 LOAD FLOW QUALITY

Requirement	Severity	Condition
LOADFLOW-Balance-01	FATAL	The absolute value of the active imbalance (sum of active generation minus active load) exceeds 5% of the total active generation including net imports
LOADFLOW-Balance-02	WARNING	After a loadflow calculation, the absolute value of the change of active nodal injection at the slack node of the largest electrical island exceeds 5% of the total active generation including net imports
LOADFLOW-PV-01	FATAL	No voltage support nodes (i.e. slack or PV node) have been provided
LOADFLOW-PV-02	WARNING	The shift of voltage magnitude on a PV node after load flow calculation is bigger than 5% of the reference voltage
LOADFLOW-PV-03	FATAL	The shift of voltage magnitude on a PV node after load flow calculation is bigger than 10% of the reference voltage
LOADFLOW-Voltage-01	WARNING	One or more calculated bus voltages are not between 0.8 Un and 1.2 Un (Un is the voltage level of the node)
LOADFLOW-Overload-01	WARNING	After load flow calculation, one or more branch flows are higher than 120% of the current limit
LOADFLOW-Vulcanus-01	WARNING	The difference between the calculated balance and the expected balance as defined in Vulcanus is greater than 50 MW
LOADFLOW-Vulcanus-02	FATAL	The difference between the calculated balance and the expected balance as defined in Vulcanus is greater than 500 MW

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3 QUALITY ASSESSMENT OF THE CALCULATIONS

The inaccuracy of the network state obtained by merging of DACF or IDCF files isn't easy to determine because unpredictable intraday modifications (topology, exchanges programs, generations…) lead to differences between forecast and measured flows. In order to have a clear view when it comes to analyse the quality, the most realistic approach to improve the quality would be first to correct all known errors and after that to monitor the differences between the forecast and measured flows on a regular basis and to analyse these differences.

3.1 QUALITY ASSESSMENT OF THE MERGED MODEL (INPUT DATA)

The following merged model quality criteria are used by the SG NM&FT Operational quality Task Force:

Requirement	Severity	Condition
MERGE-01	WARNING	The file for a specific TSO was substituted, no further quality assessment is performed for this part of the merged dataset
MERGE-02	WARNING	X-node status is not consistent (original files)
MERGE-03	WARNING	The operating limits on tie-lines are not consistent on both sides
MERGE-04	WARNING	For capacity allocation (2DCF) only: tap positions of phase shifting transformers are not in their neutral position

3.2 QUALITY ASSESSMENT OF THE MERGED MODEL (LF RESULT)

The following merged model quality criteria are used by the SG NM&FT Operational quality Task Force:

Requirement	Severity	Condition
LF-OVERLOADS-01	WARNING	Excessive equipment overloads (overloads exceeding 120% of the operating limits as provided by all TSOs) [15]
LF-REACTIVEPOWER-01	WARNING	Excessive reactive power injections at PV nodes (multiple reactive power injections at their Qlimit positions)
LF-VOLTAGES-01	WARNING	Voltages are not within the operational limits as provided by all TSOs[16]

[15] Assumed to be provided in the datasets

[16] Assumed to be provided via a questionaire

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3.3 QUALITY ASSESSMENT OF THE MERGED MODEL (AFTER THE FACT)

Topic	Form	Details
SUBSTATION INJECTIONS	Statistics	List of substations with a discrepancy between forecast injection and realized injection (i.e. sum of loads, generation and shunts)
BRANCH STATUS	Statistics	List of branches of which the status deviates between forecast and real-time
PST SETTINGS	Statistics	List of phase shifting transformers showing the forecast tap position and the actual tap position
TIE-LINE FLOWS	Statistics	List of the discrepancies between calculated flows and state estimated flows on tie-lines
BRANCH FLOWS	Statistics	List of the discrepancies between calculated flows and state estimated flows on critical branches
HVDC FLOWS	Statistics	List of the discrepancies between calculated flows and state estimated flows on HVDC lines
VOLTAGE PROFILE	Statistics	List of substations with a discrepancy between the calculated voltage and the state estimated voltage

After the fact assessment will only be performed for those TSOs that provide hourly snapshots on the EH-ftp server.

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ANNEX 1

DATA COMPLETION FOR 24 TIMESTAMPS AND QUALITY INDICATORS FOR SINGLE FILES

This section is for information purposes only and contains a strategy for building merged data sets.

In order to have 24 complete merged datasets for the DACF process, data completion must be applied. The objective is to use as much original files as possible.

The following situation might occur at gate closure time:

- 24 files expected for a TSO, all are available
- 24 files expected for a TSO, all mandatory files are available, but some other timestamps are missing
- 24 files expected for a TSO, some files are missing, of which mandatory timestamps
- 24 files expected for a TSO, all are missing

The following strategy can be suggested (after gate closure):

1. Perform a quality check on the available files (validation and load flow) and reject the bad files. The remaining files can have two types of quality indicators set: type 1 (passed without any errors) or type 2 (passed with warning issues).
2. Complete the set of files for all timestamps in the following order:
   - using first files of the same timeframe of the same day (see the table below, quality indicator is set as type 3)
   - from the same timeframe of older files of the same day type (quality indicator is set as type 4)
   - files from the same day (other timeframe, type 5)
   - older files of a different day type (quality indicator is set as type 6).
3. Perform sub control block merging and scaling. If all files of a SCB are of type 1 or type 2, then scaling needs to be performed on all files of this SCB in case the remaining slack deviation exceeds a configurable threshold. If not all files are of type 1 or type 2, then only the files of type 3, 4, 5 or 6 are to be scaled.
4. Perform the scaling of the other files and merging of the scaled SCBs and other files. The scaling is performed by changing loads to match the Vulcanus values by default.
5. Run a load flow on the merged file and distribute the remaining slack deviation on the loads all over the grid. This will be the base case for further calculations.

Other grid changes, including contingency cases will use generation slack based on GSK values.

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Time	Received timestamp	Transformed timestamp
0:30		03:30
1:30		03:30
2:30		03:30
3:30	03:30	03:30
4:30		03:30
5:30		07:30
6:30		07:30
7:30	07:30	07:30
8:30		07:30
9:30		10:30
10:30	10:30	10:30
11:30		10:30
12:30	12:30	12:30
13:30		12:30
14:30		12:30
15:30		12:30
16:30		17:30
17:30	17:30	17:30
18:30		17:30
19:30	19:30	19:30
20:30		19:30
21:30		19:30
22:30		19:30
23:30		19:30

Scaling and merging is described in the following section in more detail.

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Merging

SUB CONTROL BLOCK MERGING AND SCALING

In order to be able to check the (sub) control block LF balances with the Vulcanus data (quality assessment) the sub control blocks must be merged first.

The following automated steps might be applied:

1. Remove the x-node injections on matching x-node pairs
2. Correct the x-node status inconsistencies, according to the following algorithm:
    a. In case of a discrepancy between an original file and a substituted file, the status of the original file is used
    b. In case of a discrepancy between two substituted files, the status is set to “disconnected”
    c. In case of a discrepancy between two original files, the status is set to “disconnected”
3. Correct the remaining x-node injections to match Vulcanus value (only active load), taking into account x-nodes that are not included in the Vulcanus exchange value
4. Use the substitution status (see chapter 3)
5. Change the slack node status to PV node status, except for the slack node with the largest generator attached to it
6. Run a load flow
7. Perform load redistribution:
    a. If one or more files were substituted, redistribute the imbalance value proportionally over the positive loads of the substituted file(s), maintaining the power factor of these loads
    b. If none were substituted, redistribute the imbalance value proportionally over the positive loads of all files, maintaining the power factor of these loads
8. Write the output values for PV node injections and voltages to the input sub control block file

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CREATION OF A FULL INTERCONNECTED MODEL

For the creation of a full interconnected model, which can consist of the complete RGCE network or any subset, a merge of the control blocks is performed.

The following automated steps might be applied:

1. Remove the x-node injections on matching x-node pairs
2. Correct the x-node status inconsistencies, according to the following algorithm:
    a. In case of a discrepancy between an original file and a substituted file, the status of the original file is used
    b. In case of a discrepancy between two substituted files, the status is set to “disconnected”
    c. In case of a discrepancy between two original files, the status is set to “disconnected”
3. Change the slack node status to PV node status, except for the slack node with the largest generator attached to it. The slack node must be in a central position of the grid, with sufficient interconnections.
4. Run a load flow
5. Perform load redistribution:
    a. If one or more files were substituted, redistribute the imbalance value proportionally over the positive loads of the substituted file(s), maintaining the power factor of these loads
    b. If none were substituted, redistribute the imbalance value proportionally over the positive loads of all files, maintaining the power factor of these loads
6. Write the output values for PV node injections and voltages to the input sub control block file

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