DIgSILENT GridCode:

LVRT in South Africa with DIgSILENT GridCode

DIgSILENT Ibérica
Madrid, 30 August 2011

South African Study Case

New document in South Africa: "GRID CODE COMPLIANCE TEST FOR WIND ENERGY FACILITY CONNECTED TO TRANSMISSION OR DISTRIBUTION GRIDS IN SOUTH AFRICA"

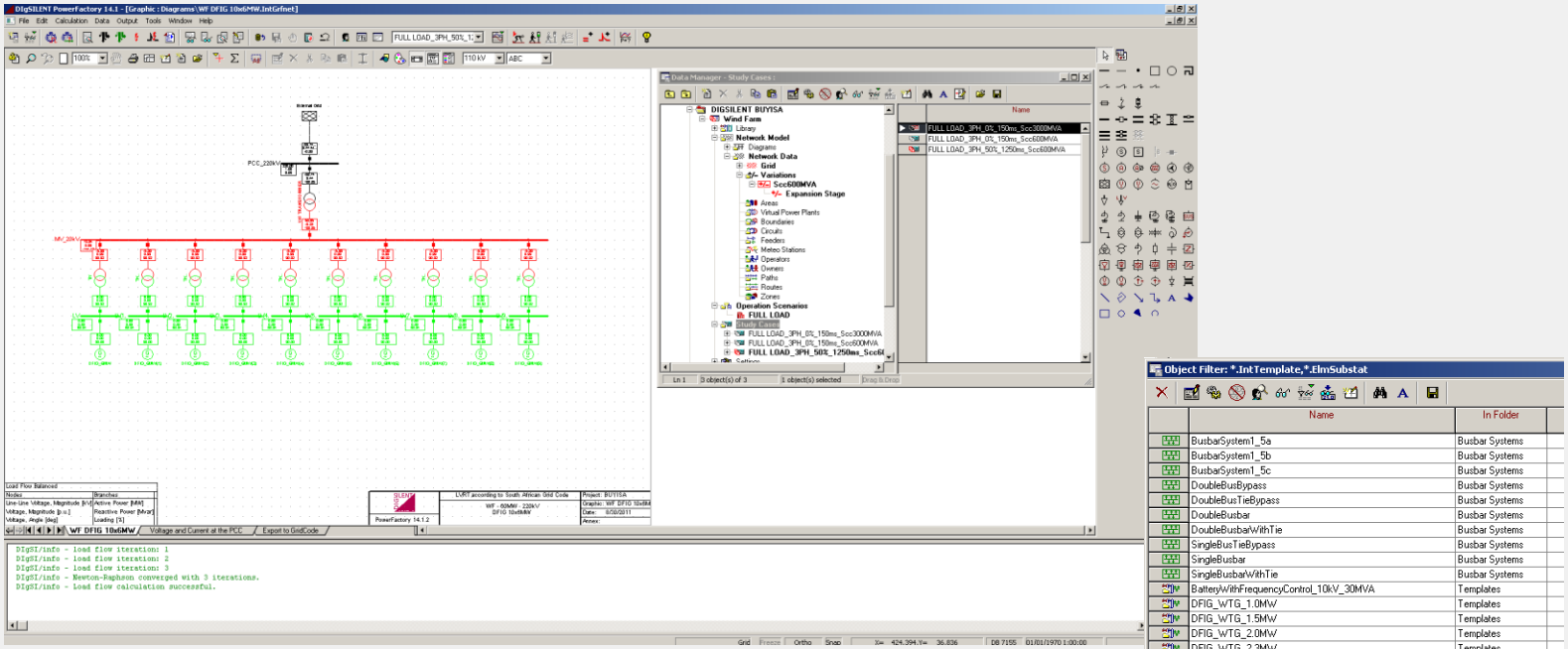
The wind farm must be tested:

- FIELD TESTING:
  - ACTIVE POWER MANAGEMENT TEST
  - SYSTEM VOLTAGE REQUIREMENTS
  - SIGNALS, COMMUNICATION AND CONTROL
- DYNAMIC SIMULATIONS:
  - SIMULATION 1: FAULT RIDE THROUGH CAPABILITY
  - SIMULATION 2: FAST ACTING REACTIVE AND/OR ACTIVE POWER CONTRIBUTION DURING FAULTS
  - SIMULATION 3: POST FAULT ACTIVE POWER RECOVERY
  - SIMULATION 4: POWER OSCILLATIONS DAMPING CAPABILITY
  - SIMULATION 5: SYNTHETIC INERTIAL CAPABILITY

Example of Dynamic Simulation Testing Procedure

Example of Dynamic Simulation Testing Procedure

STEP 1: Building the Wind farm dynamic model in DIgSILENT PowerFactory 14.1.2



NOTE: this example is built using templates in the global library;

Doubly Fed Induction Generators rated 6MW→ DFIG_WTG_6MW

Wind Farm Rated Power: 60MVA

Wind Farm Rated Voltage: 220kV

Example of Dynamic Simulation Testing Procedure

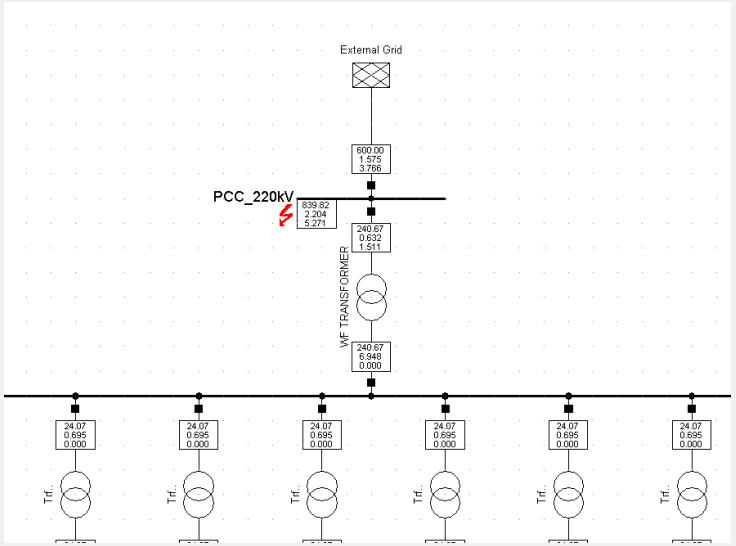
STEP 2: Simulation of LVRT events according to the South African Grid Code:

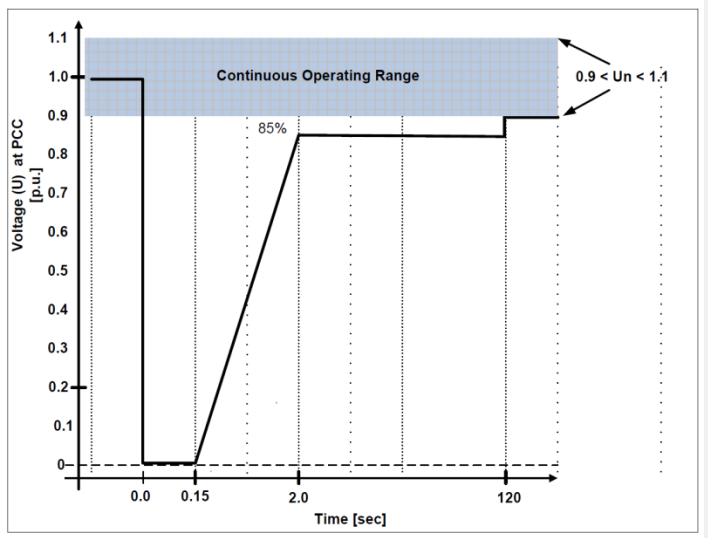
EMT simulation - 10kHz time step

Voltage dip location: at the Wind Farm PCC, 220kV side

Voltage dip depth: 0%, 50%, 85%

Voltage dip length: 150ms, 1250ms, 120s





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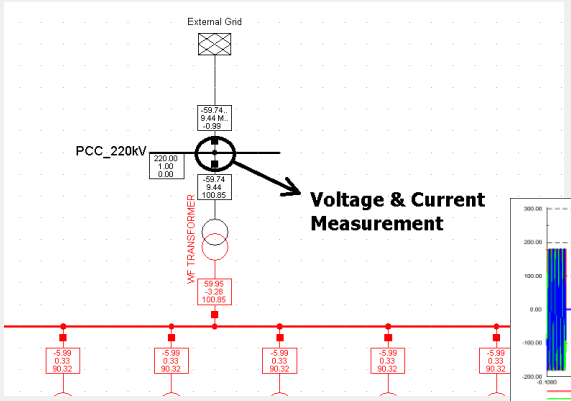
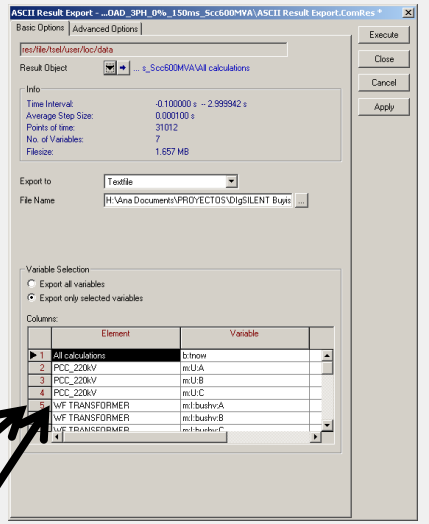
STEP 3: Export required signals from Plots in PowerFactory:

Ua(t), Ub(t), Uc(t) → kV

Ia(t), Ib(t), Ic(t) → kA

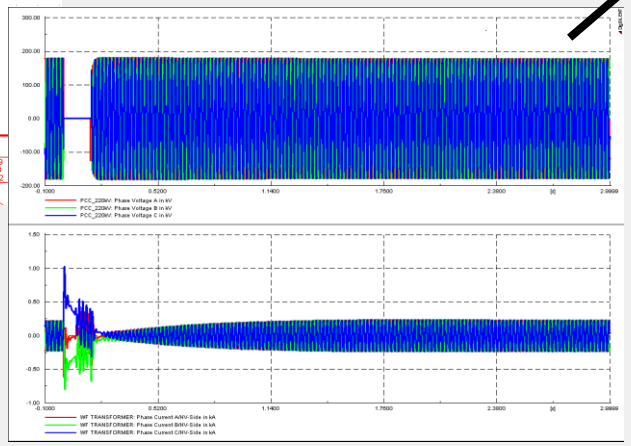
Textfile, white space/tab separated format



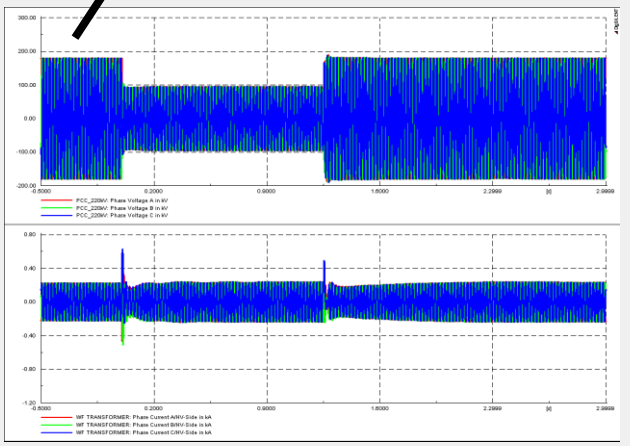


Export

Voltage dip 0%



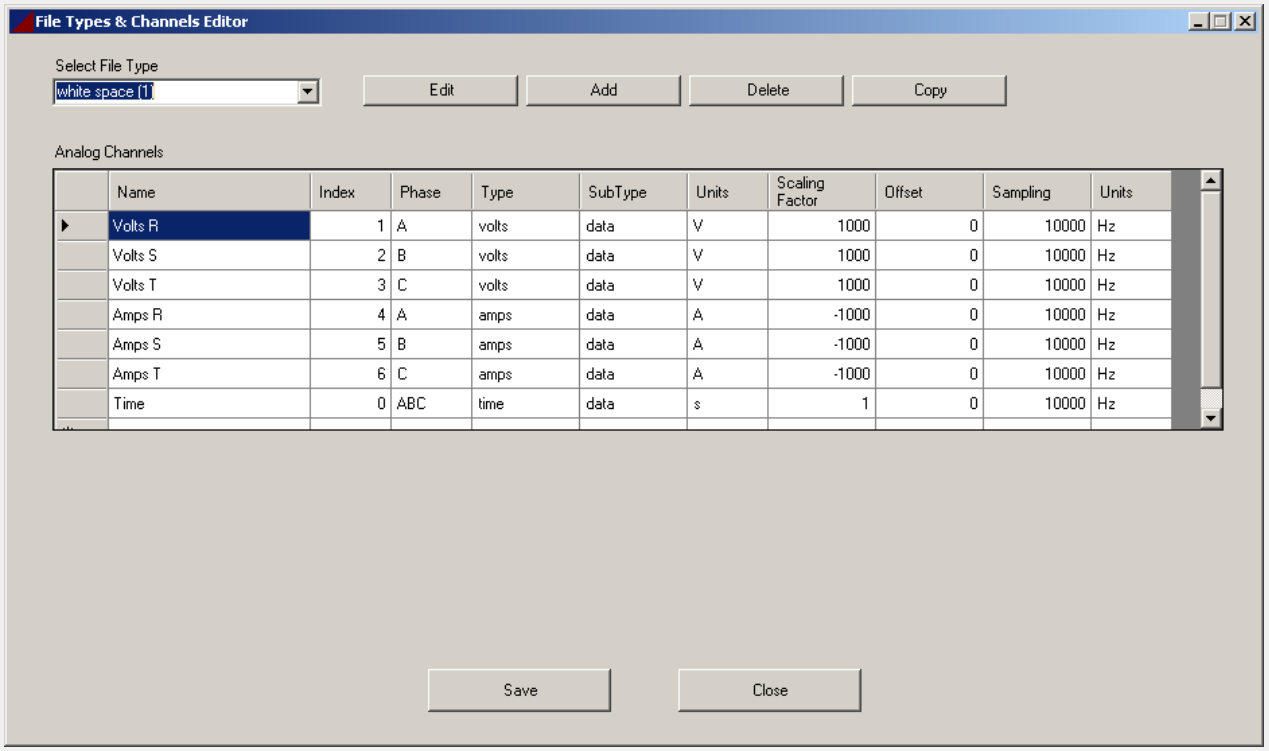
Voltage dip 50%



Example of Dynamic Simulation Testing Procedure

STEP 4: Analysis with DIgSILENT GridCode, checking for compliance.

STEP 4.1: File Types & Channels to read the results file.



	Name	Index	Phase	Type	SubType	Units	Scaling Factor	Offset	Sampling	Units
▶	Volts R	1	A	volts	data	V	1000	0	10000	Hz
	Volts S	2	B	volts	data	V	1000	0	10000	Hz
	Volts T	3	C	volts	data	V	1000	0	10000	Hz
	Amps R	4	A	amps	data	A	-1000	0	10000	Hz
	Amps S	5	B	amps	data	A	-1000	0	10000	Hz
	Amps T	6	C	amps	data	A	-1000	0	10000	Hz
	Time	0	ABC	time	data	s	1	0	10000	Hz

Example of Dynamic Simulation Testing Procedure

STEP 4: Analysis with DIgSILENT GridCode, checking for compliance.

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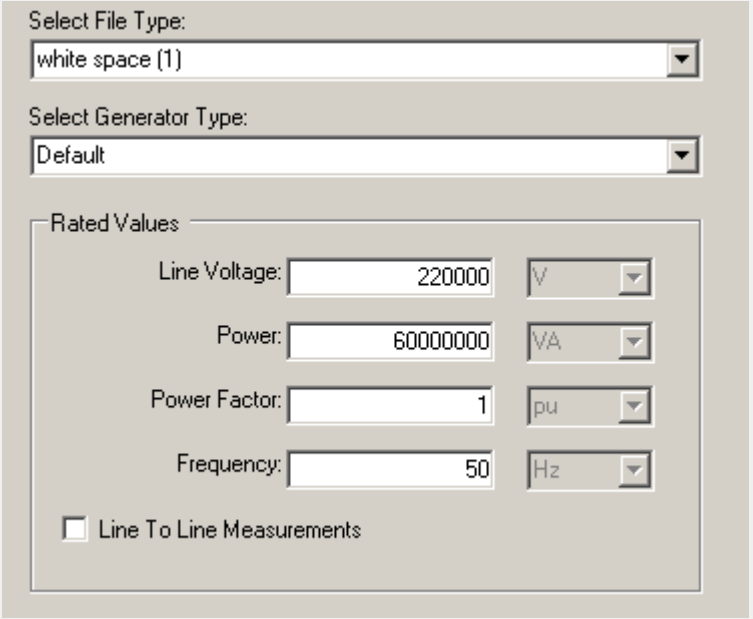
STEP 4.2: Input of base values → 60MVA and 220kV



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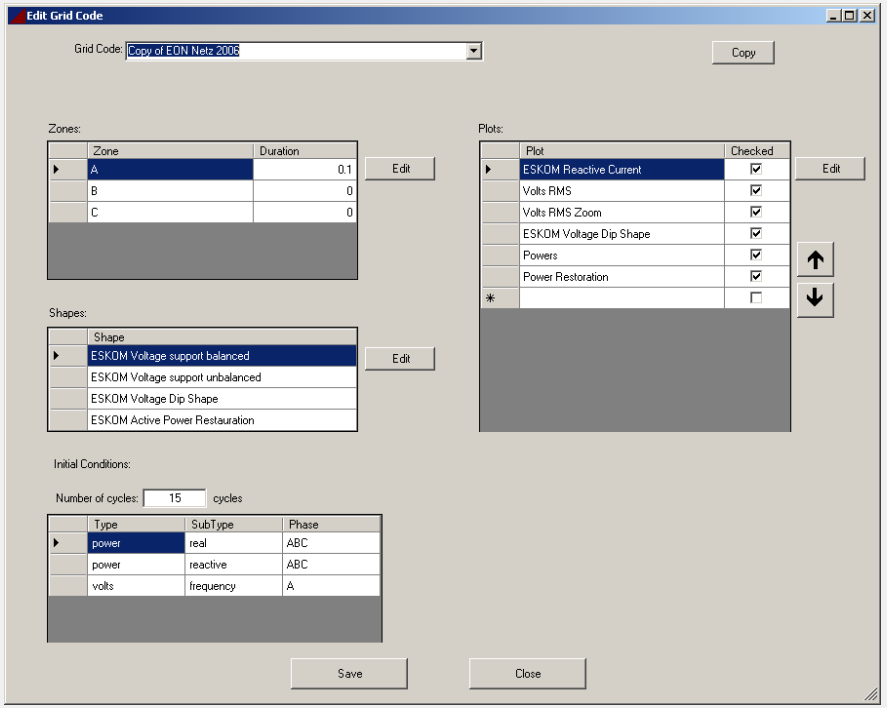
STEP 4.3: With the GridCode Editor, add the South African Grid Code (copying for example the EON Netz 2006)



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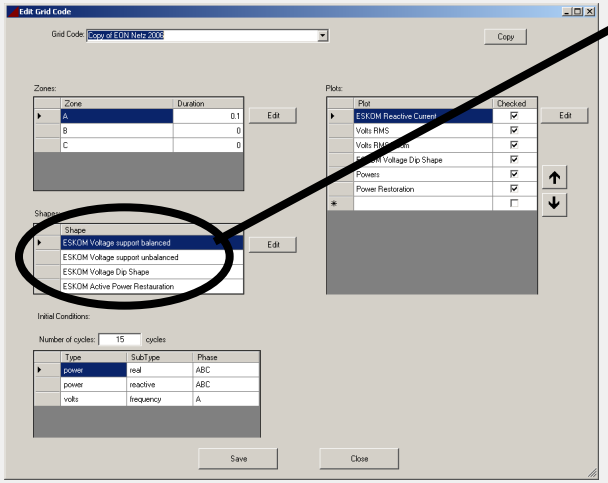
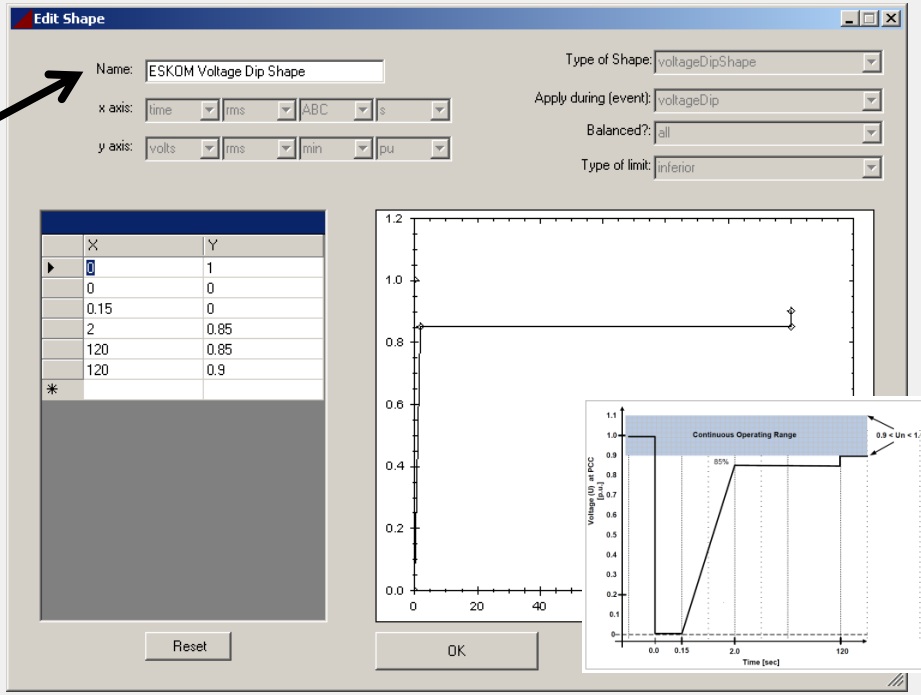
- Edit the voltage dip shape for balanced and unbalanced dips to the ESKOM dip





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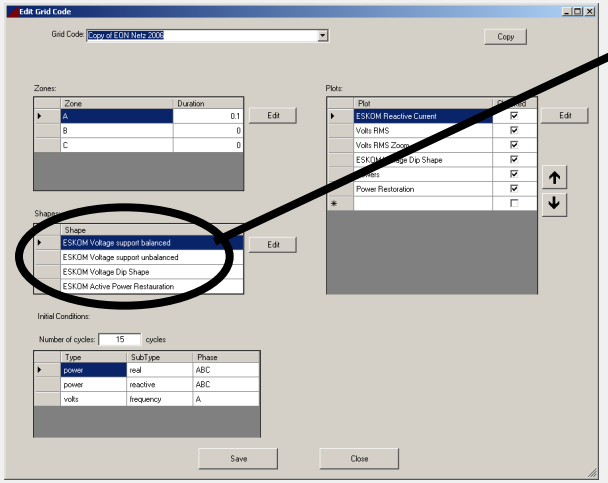
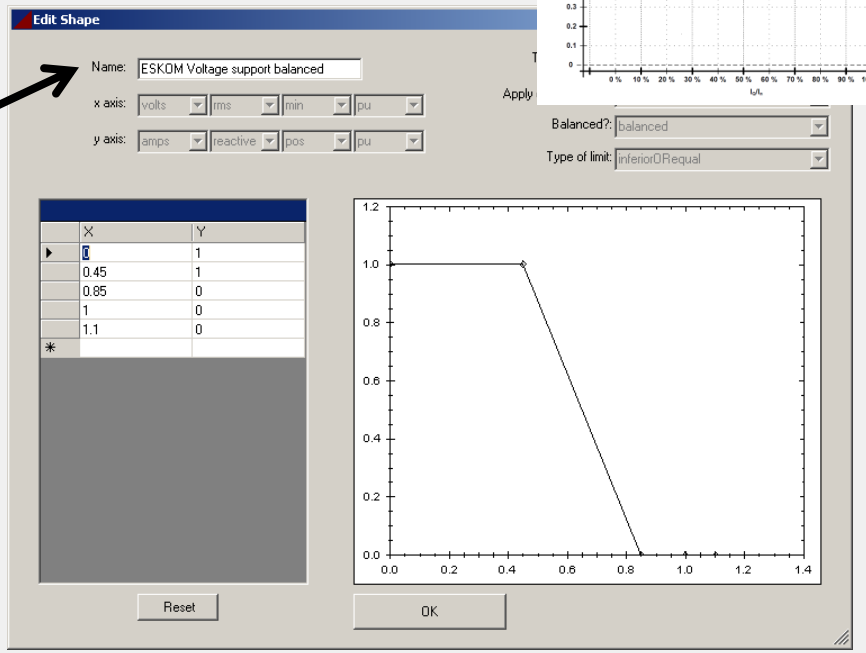
STEP 4.3: With the GridCode Editor, add the South African Grid Code (copying for example the EON Netz 2006)

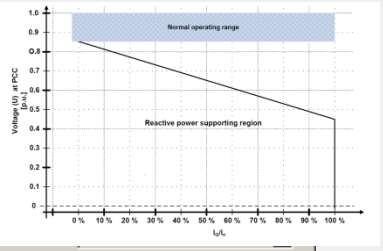
- Edit the voltage dip shape to the ESKOM dip shape.
- Edit the voltage support requirements

to the ESKOM requirements.

- Save.







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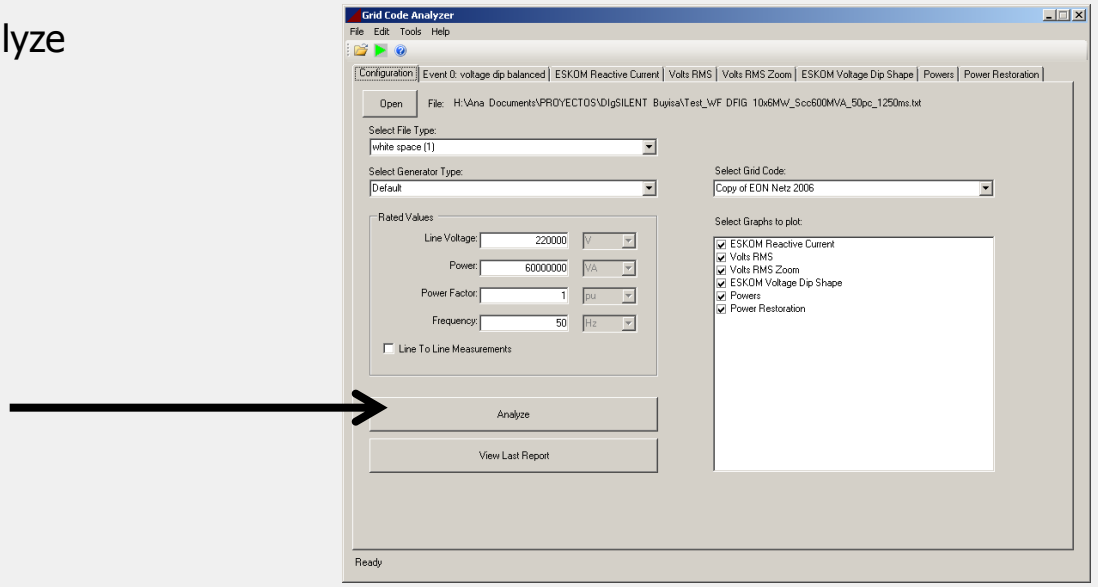
- Edit the voltage support requirements to the ESKOM requirements.
- Save.

STEP 4.4: Click Analyze



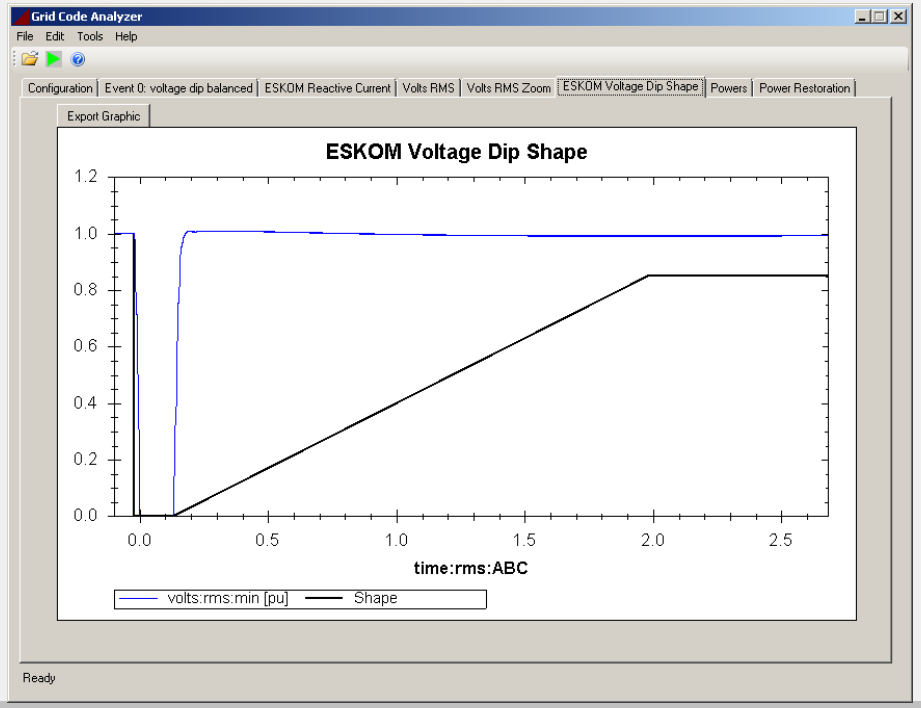
Example of Dynamic Simulation Testing Procedure

RESULTS

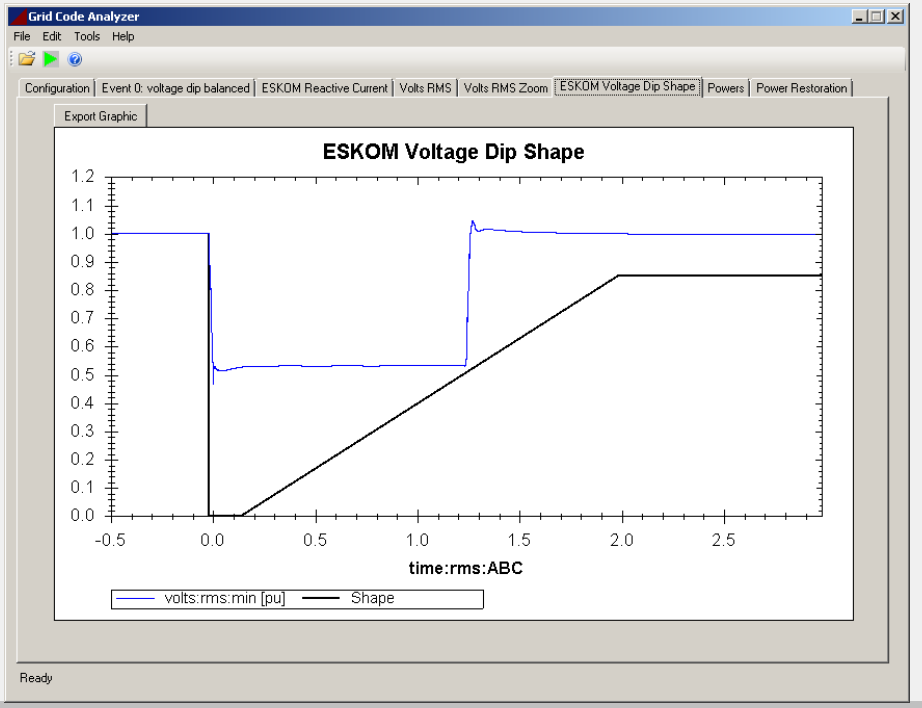
The ESKOM Voltage Dip Shape Graph allows to check if the voltage dip is "inside" the voltage dip shape → the wind farm can not disconnect and must provide reactive support

→ CHECKING FAULT RIDE THROUGH CAPABILITY

Voltage dip 0%



Voltage dip 50%



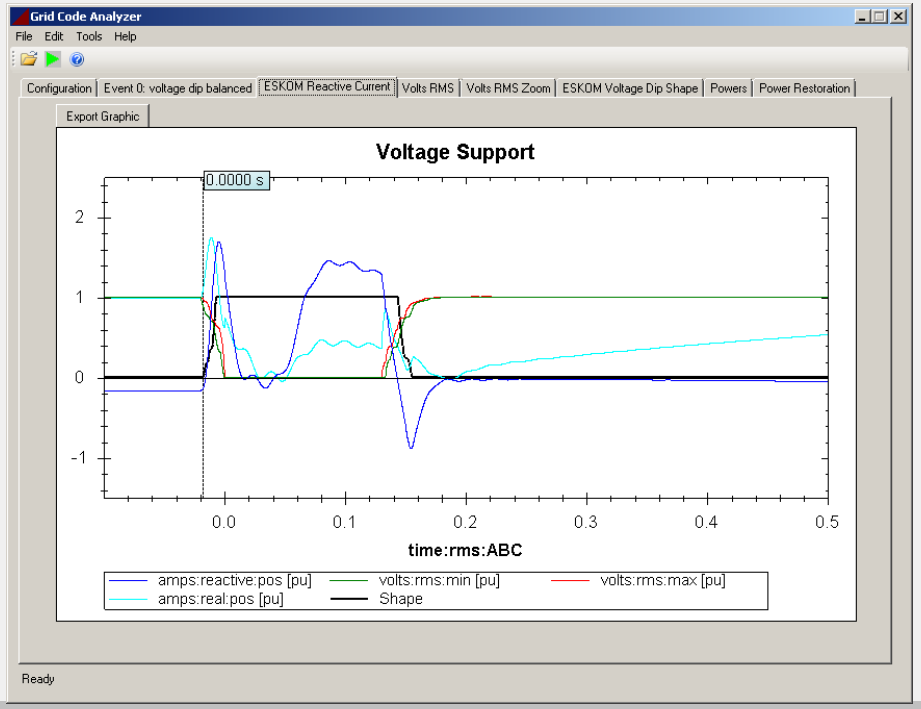
Example of Dynamic Simulation Testing Procedure

RESULTS

The Voltage Support Graph allows to check if the Wind Farm is injecting positive sequence reactive current (in dark blue) over the limit (in black) or positive sequence active current (in light blue)

→ CHECKING FAST ACTING REACTIVE AND/OR ACTIVE POWER CONTRIBUTION DURING FAULTS

Voltage dip 0%



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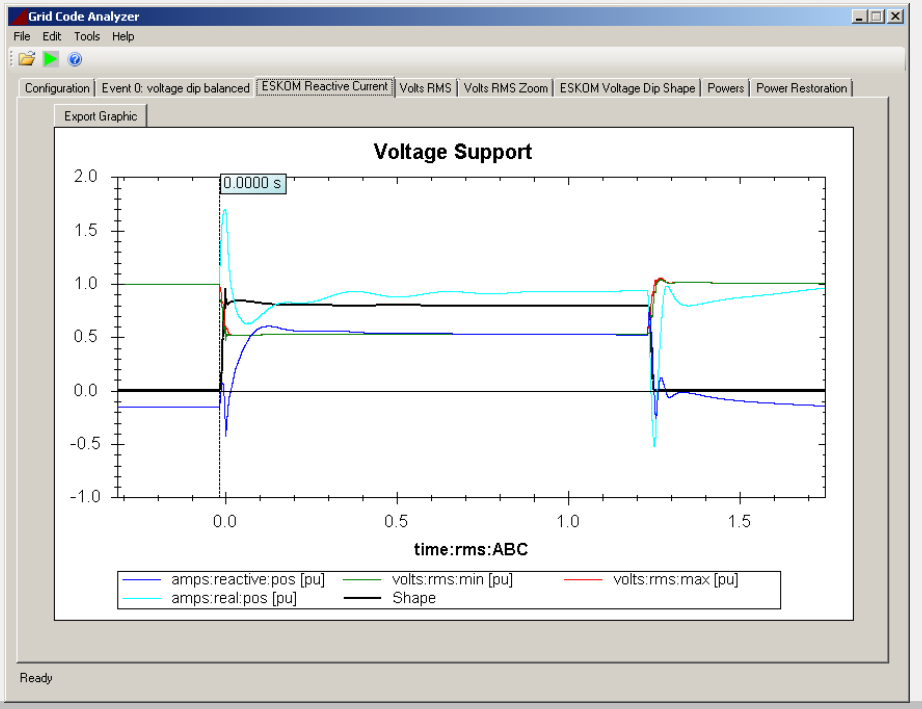


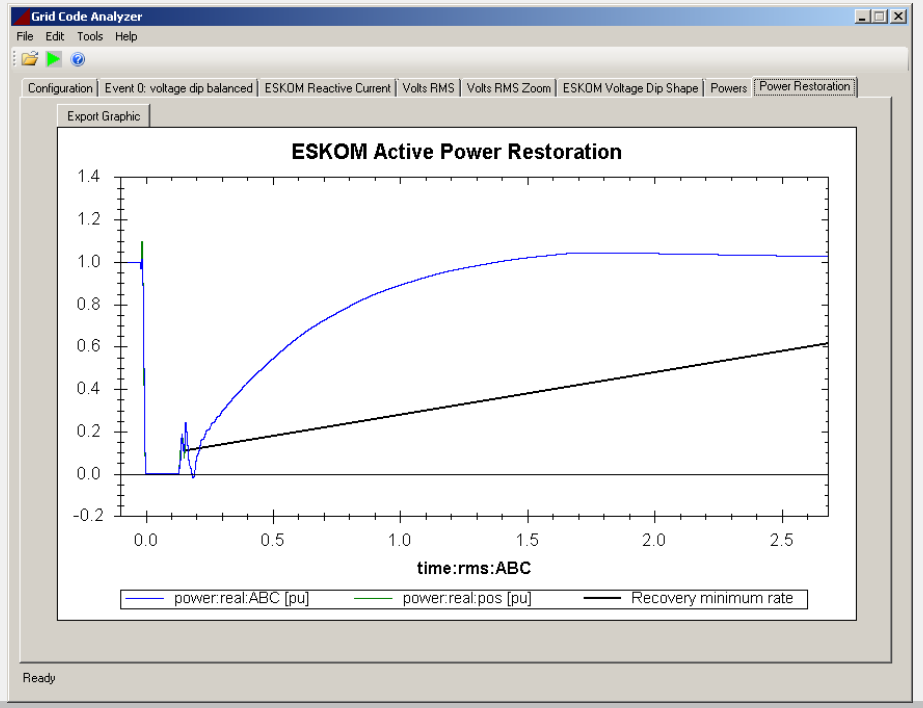
Example of Dynamic Simulation Testing Procedure

RESULTS

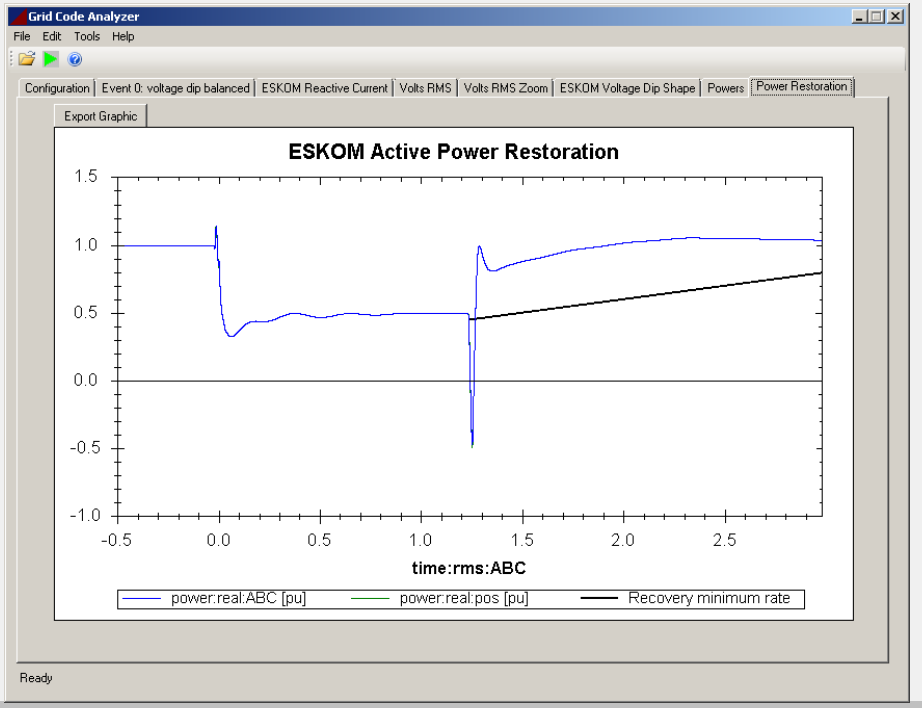
The ESKOM Active Power Restoration Graph allows to compare the required restoration active power rate and the active power from the wind farm after the voltage dip

→ CHECKING POST FAULT ACTIVE POWER RECOVERY

Voltage dip 0%



Voltage dip 50%



Example of Dynamic Simulation Testing Procedure

REPORTING

Results are reported in Word format.

DIgSILENT Grid Code - Compliance Report
South African Grid Code

Rated Values: Default	
System Frequency	50 Hz
Rated Apparent Power	60,000,000 VA
Rated Voltage	220,000 V
Rated Power Factor	1.0

Event	Magnitude	Duration	Phase(s)
voltage dip balanced	0.466	1.2678 s	ABC

Previous Conditions (15 cycles):

Condition	Value	Units
power:real:ABC [pu]	0.996	pu
power:reactive:ABC [pu]	-0.157	pu
volts:frequency:A [Hz]	49.440	Hz

Grid Code: Copy of EON Netz 2006

Zone	Limit	Min/Max	Result
A	time to inject reactive current <= 0.1 s	0.000	☑
B	injecting required reactive current during the whole event?	0.000	☒
	TOTAL		☒

Voltage Support

Volts RMS

Volts RMS Zoom

DIgSILENT GridCode Contact

Ana Morales/Xavier Robe
DIgSILENT Ibérica S.L.
Ribera del Loira, 46
28042 Madrid – Spain
Phone: +34 911273723/24
Email:
a.morales@digsilent.com
x.robe@digsilent.com
Website:
www.digsilent.com